Arthropoda Selecta 15 (3): 203–210

Lamiantennula gen.n. (Copepoda: Calanoida): a new deep-water benthopelagic genus of Arietelloidea

Lamiantennula gen.n. (Copepoda: Calanoida): новый глубоководный бентопелагический род Arietelloidea

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KEY WORDS: Copepoda, Calanoida, taxonomy, deep sea, benthopelagic, Weddell Sea.

КЛЮЧЕВЫЕ СЛОВА: Copepoda, Calanoida, таксономия, глубоководный, бентопелагический, море Уэдделла.

ABSTRACT. A single adult female specimen of a new genus and species, *Lamiantennula longifurca,* was collected from the Weddell Sea (Southern Ocean) in 2002 during ANDEEP II expedition in vicinity of the abyssal sea bed. *Lamiantennula longifurca* is unique among calanoid copepods in the presence of a lamelliform antennulary complex composed of three proximal segments. The genital double-somite of the new genus is asymmetrical and the caudal rami are exceptionally long. The new genus is distinguished among arietelloideans in armament of the mandible endopod segment 2 bearing 2 setae, one seta having a collar around its base; exopod with 5 setae; in maxillule with strongly enlarged praecoxal arthrite, basal endites absent, and epipodite lacking setae; in leg 1 exopod segment 2 without lateral spine. The new genus does not fit the diagnosis of any family of the superfamily Arietelloidea, however, due to the setation of oral parts and leg 1 it is provisionally placed within Hyperbionychidae. *Lamiantennula longifurca* is the first benthopelagic arietelloidean calanoid copepod described from Antarctic waters.

РЕЗЮМЕ. Один экземпляр самки нового рода и вида, *Lamiantennula longifurca,* был найден в 2002 году в абиссали моря Уэдделла (Южный Океан) экспедицией ANDEEP II в непосредственной близости у дна. *Lamiantennula longifurca* обладает уникальной для каланоида особенностью — комплексом в виде пластинки из трех слившихся проксимальных сегментов антеннул. Генитальный сомит нового рода асимметричен, а каудальные ветви исключительно длинные. Новый род отличен от остальных Arietelloidea также наличием 2 щетинок на сегменте 2 эндоподита мандибулы, одна из которых снабжена «воротничком» у основания; экзоподит с 5 щетинками; максиллула с сильно увеличенным прекоксальным артритом, базальные эндиты отсутствуют, и на эпиподите щетинки отсутствуют; сегмент 2 экзоподита первой пары плавательных ног без наружного шипа. Новый род не соответствует диагнозу ни одного из семейств надсемейства Arietelloidea, однако, тип вооружения ротовых частей и первой пары плавательных ног сходен с таковым Hyperbionychidae, поэтому временно род помещен в это семейство. *Lamiantennula longifurca* — первый представитель бентопелагических Arietelloidea описанный их Антарктических вод.

Printed in 2007.

Introduction

Many new taxa found recently during near-bottom sampling above the sea bed in the Southern Ocean testify to a high biodiversity of the benthopelagic calanoid fauna [Bradford & Wells, 1983; Ohtsuka *et al.*, 1998; Schulz, 1996, 1998, 2002, 2005; Schulz & Markhaseva, 2000; Markhaseva & Dahms, 2004; Markhaseva & Schulz, 2006]. Sampling of the abyssal near-bottom environment by epibenthic sledge during ANDEEP II expedition in 2002 in the Weddell Sea [Brandt *et al.*, 2004] added one more new benthopelagic calanoid genus and species to this list. However, the distributional range of the new genus appears wider than Antarctic waters, as a juvenile female was obtained also from the abyss of the south-eastern Atlantic near the sea bed by DIVA I expedition in 2000. *Lamiantennula longifurca* found in the abyss of the Weddell Sea is the first benthopelagic representative of the superfamily Arietelloidea recorded from Antarctic waters. While the new genus is tentatively placed in Hyperbionychidae, it is very probable that after discovery of the male a new family may have to be established.

Material and methods

A single specimen was collected during ANDEEP II expedition of R/V *Polarstern* cruise ANT XIX–4 from station 136–4 in the Antarctic Weddell Sea at abyssal depths (4748–4743 m) on 13 March 2002 by the supranet of an epibenthic sledge [Brandt & Barthel, 1995], sampling layer ca. 1.0–1.3 m above the bottom; mesh size 0.3 mm. A single juvenile female (copepodite stage IV) was obtained during DIVA I expedition of FS *Meteor* cruise 48–1 from station 344 in the south-eastern Atlantic (17º06'S 04º42'E) by similar gear close to the bottom at depth of 5415 m on 25 July 2000.

The material was fixed in 96% ethanol, specimens were stained by adding a solution of chlorazol black E dissolved in 70% ethanol/30% water. Oral parts and swimming legs were dissected, mounted in glycerin, and figures prepared using a *camera lucida*.

The following abbreviations are used in the descriptions: free segments of the antennules are designated by Arabic numerals, ancestral segments by Roman numerals. One seta and one aesthetask on a segment of the antennule are designated: 1s + 1ae; "1?" indicates that a setal element was broken so that its identity on antennule could not be determined and only the scar at the location of its attachment was counted. The maxilliped syncoxa is considered having three praecoxal lobes and one coxal lobe [Ferrari & Markhaseva, 2000a, b; Ferrari & Ivanenko, 2001].

Type material is deposited in the Zoological Museum Hamburg (ZMH), University of Hamburg.

Taxonomy

Superfamily Arietelloidea Sars, 1902

Family Hyperbionychidae Ohtsuka, Roe & Boxshall, 1993

Genus *Lamiantennula* **gen.n.**

Type species *Lamiantennula longifurca* sp.n.

DESCRIPTION. Female. Cephalosome and first pedigerous somite separate, pedigerous somites 4–5 fused. Rostrum with 2 long filaments. Genital double-somite and its structures asymmetrical. Caudal rami symmetrical, longer than urosomites 1–4. Proximal segments of antennule fused as lamelliform complex. Mandibular basis without seta; endopod segment 1 without seta, segment 2 with 2 terminal setae, one thicker, poorly sclerotized; exopod with 5 setae; gnathobase with 6 terminal and 1 lateral subdistal teeth. Praecoxal arthrite of maxillule strongly enlarged with 16 setal elements; coxal endite with 3 setae; basal endites reduced; endopod with 3 setae; exopod with 2 setae; coxal epipodite without setae. Maxilla proximal praecoxal endite with 5 setae, distal praecoxal endite with 1 seta; proximal coxal endite with 2 setae, distal coxal endite with 3 setae; proximal basal endite with 4 setae and outer crest; terminal part of limb with 4 setal elements on endite and endopod with 7 setae. Maxilliped proximal and medial endites of praecoxa with 1 seta each, distal endite with 2 setae and coxal endite with 2 setae; basis with 3 medial seta; endopod 6-segmented, segment 1 separate from basis. Leg 1 basis with poorly sclerotized spine on posterior surface; endopod and exopod 3-segmented; exopod segment 2 without spine, segment 3 with 1 distolateral spine. Legs 2–4 with 3-segmented endo- and exopods. Basis of legs 3–4 with 1 distolateral seta each. Leg 5 symmetrical, uniramous, 2-segmented; segment 1 with 1 lateral seta, segment 2 with terminal setae.

Male unknown.

ETYMOLOGY. From "lamella" (Latin, meaning thin platelet) and "antennula" referring to the shape of proximal antennulary segments. Gender feminine.

REMARKS. The new genus attributed to the family Arietelloidea is diagnosed by the following apomorphies: i) antennulary proximal segments I–III fused and greatly enlarged as a lamelliform complex; ii) mandibular endopod segment 2 with 2 setae distally, one poorly sclerotized (3, 5, 7 or 9–10 setae in other arietelloideans [Soh, 1998]); iii) mandibular exopod segment 5 with 1 seta (2 setae in other arietelloideans [Soh, 1998]); iv) maxillary basis with angular outer crest.

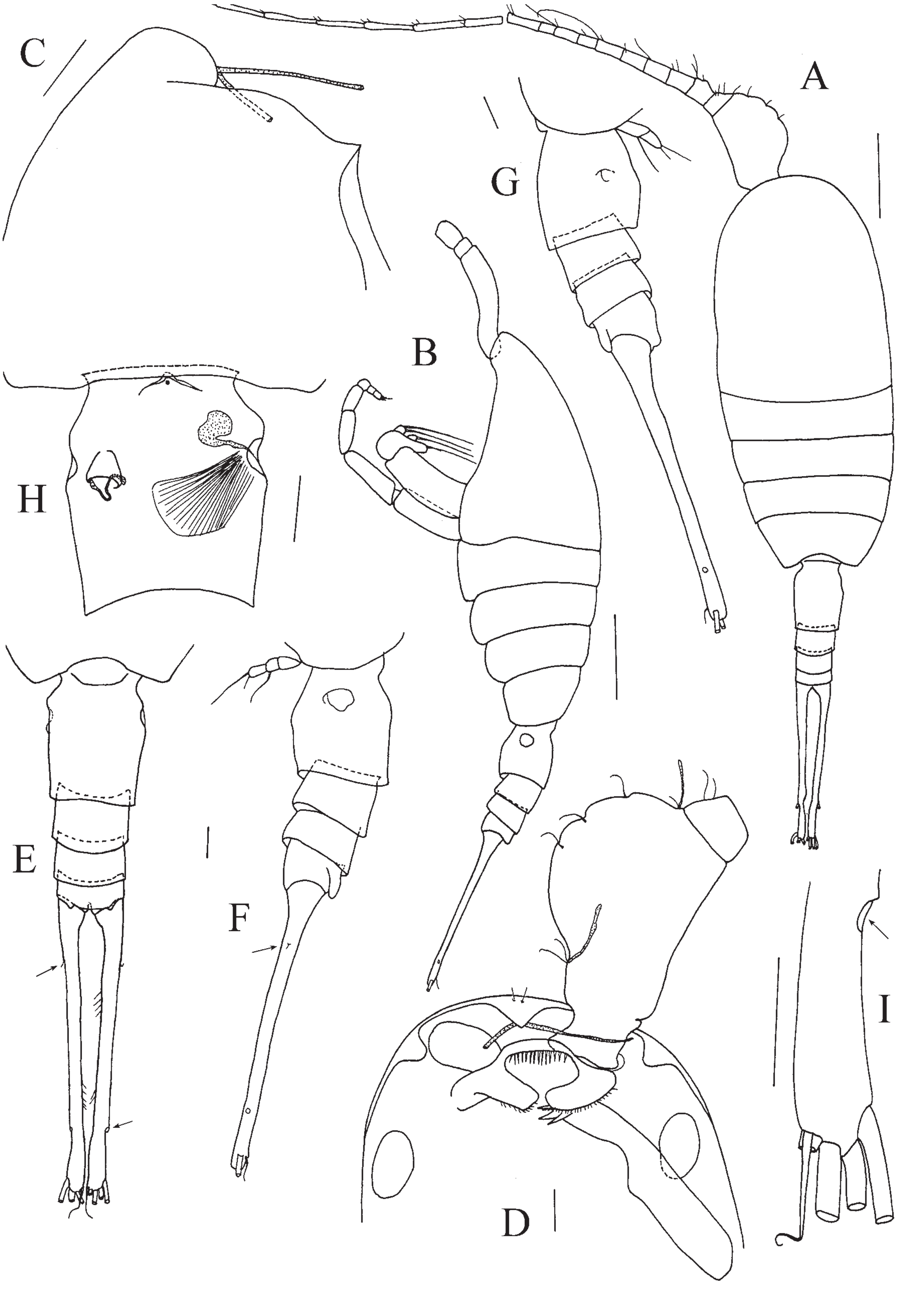
Lamiantennula longifurca **sp.n.**
Figs 1–4.

MATERIAL. Holotype. Adult female (ZMH Reg. N. K–41172). Southern Ocean, Weddell Sea (64º02′S 39º07′W), 13 March 2002, above the sea bed at 4748–4743 m.

DESCRIPTION. Female: total length 3.70 mm. Prosome 1.4 times as long as urosome. Rostrum with 2 long and slender filaments (Fig. 1C–D). Cephalosome separate from pediger 1, pedigers 4–5 completely fused; posterior corners of prosome as short rounded lobes (Fig. 1A–B, E–G). Genital double-somite longer than urosomites 2–4, slightly asymmetrical in dorsal view; genital structures asymmetrical (Fig. 1H). Anal somite shortest. Caudal rami symmetrical, 1.2 times as long as urosomites 1–4, with 7 setae: 1 small proximal lateral seta, 1 distal lateral seta broken (only scar

Fig. 1. *Lamiantennula longifurca* gen. et sp.n., holotype: A — habitus, dorsal view; B — habitus, lateral view; C — cephalosome and rostrum, lateral view; D — anterior part of cephalosome, ventral view, showing rostrum, labrum, mandibular gnathobase and proximal segments of left antennule; E — urosome, dorsal view (upper arrow indicates proximal vestigial lateral seta, lower arrow indicates scar from broken distal lateral seta); F — urosome, lateral view; G — urosome, lateral view; H — genital double-somite, ventral view; I, distal part of right caudal ramus, dorsal view (arrow indicates distal lateral seta broken, only scar is observed). Scale bars 0.5 mm for A–B, 0.1 mm for C–I.

Fig. 1. *Lamiantennula longifurca* gen. et sp. nov., голотип: A — общий вид со спины; B — общий вид сбоку; C — цефалосома и рострум, вид сбоку; D — передняя часть цефалосомы, вид с брюшной стороны, видны рострум, лабрум, гнатобаза мандибулы и проксимальные сегменты левой антеннулы; E — уросома, вид со спины (верхняя стрелка указывает на проксимальную рудиментарную боковую щетинку, нижняя стрелка указывает на след от обломанной дистальной боковой щетинки); F — уросома, вид сбоку; G — уросома, вид сбоку; H — генитальный сомит, вид с брюшной стороны; I, дистальная часть правой каудальной ветви, вид со спины (стрелка указывает на след от обломанной дистальной боковой щетинки). Масштаб 0,5 мм для A–B, 0,1 мм для C–I.



C
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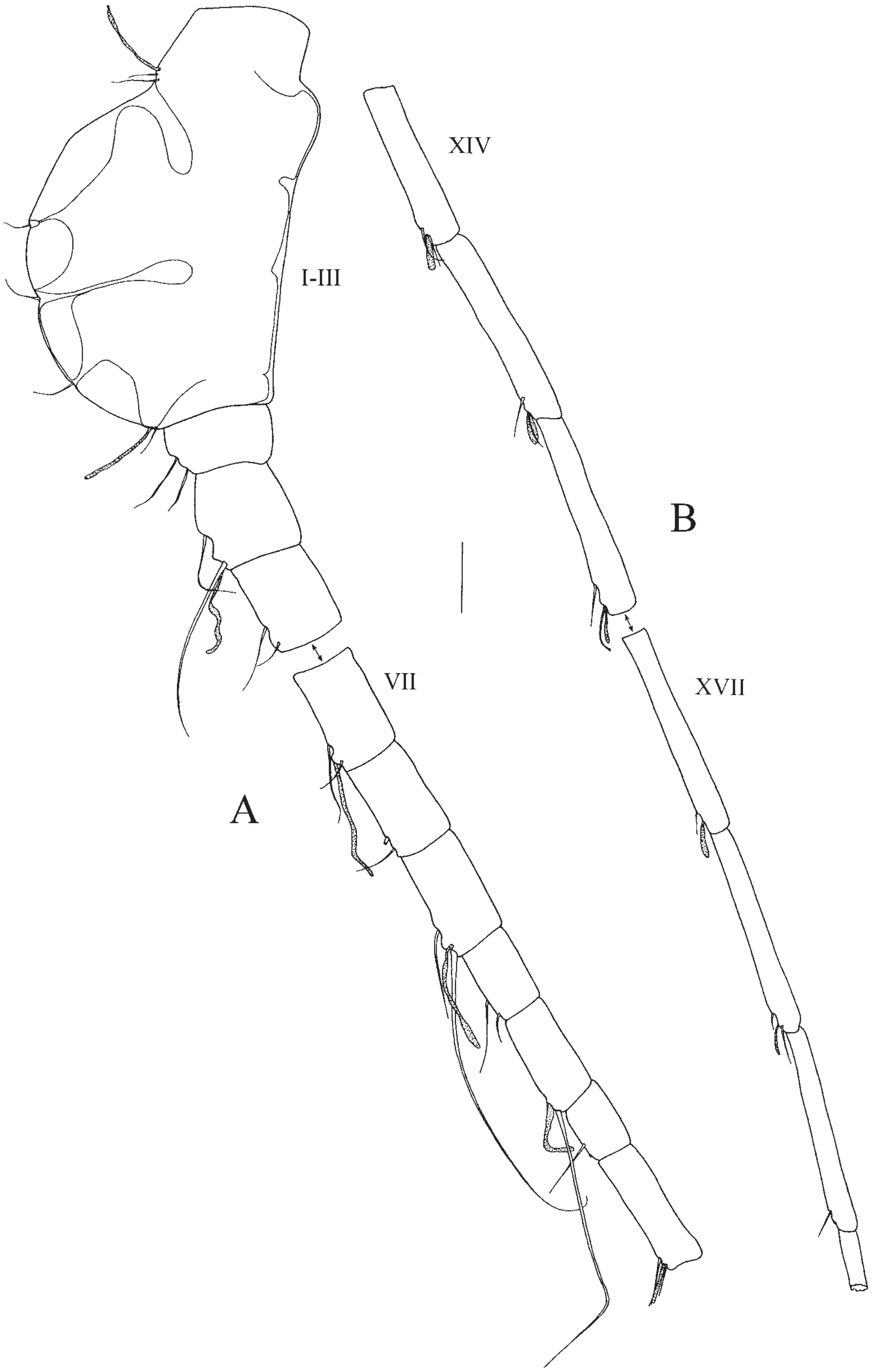


Fig. 2. *Lamiantennula longifurca* gen. et sp.n., holotype: A — left antennule, free segments 1–11 (ancestral segments I–III, IV–XIII, segment 1 is a complex of ancestral segments I–III); B — left antennule, free segments 12–17 (ancestral segments XIV–XIX), segment 18 broken. Scale bars 0.1 mm.

Fig. 2. *Lamiantennula longifurca* gen. et sp.n., голотип: A — левая антеннула, свободные сегменты 1–11 (анцестральные сегменты I–III, IV–XIII, сегмент 1 является комплексом из анцестральных сегментов I–III); B — левая антеннула, свободные сегменты 12–17 (анцестральные сегменты XIV–XIX), сегмент 18 обломан. Масштаб 0,1 мм.

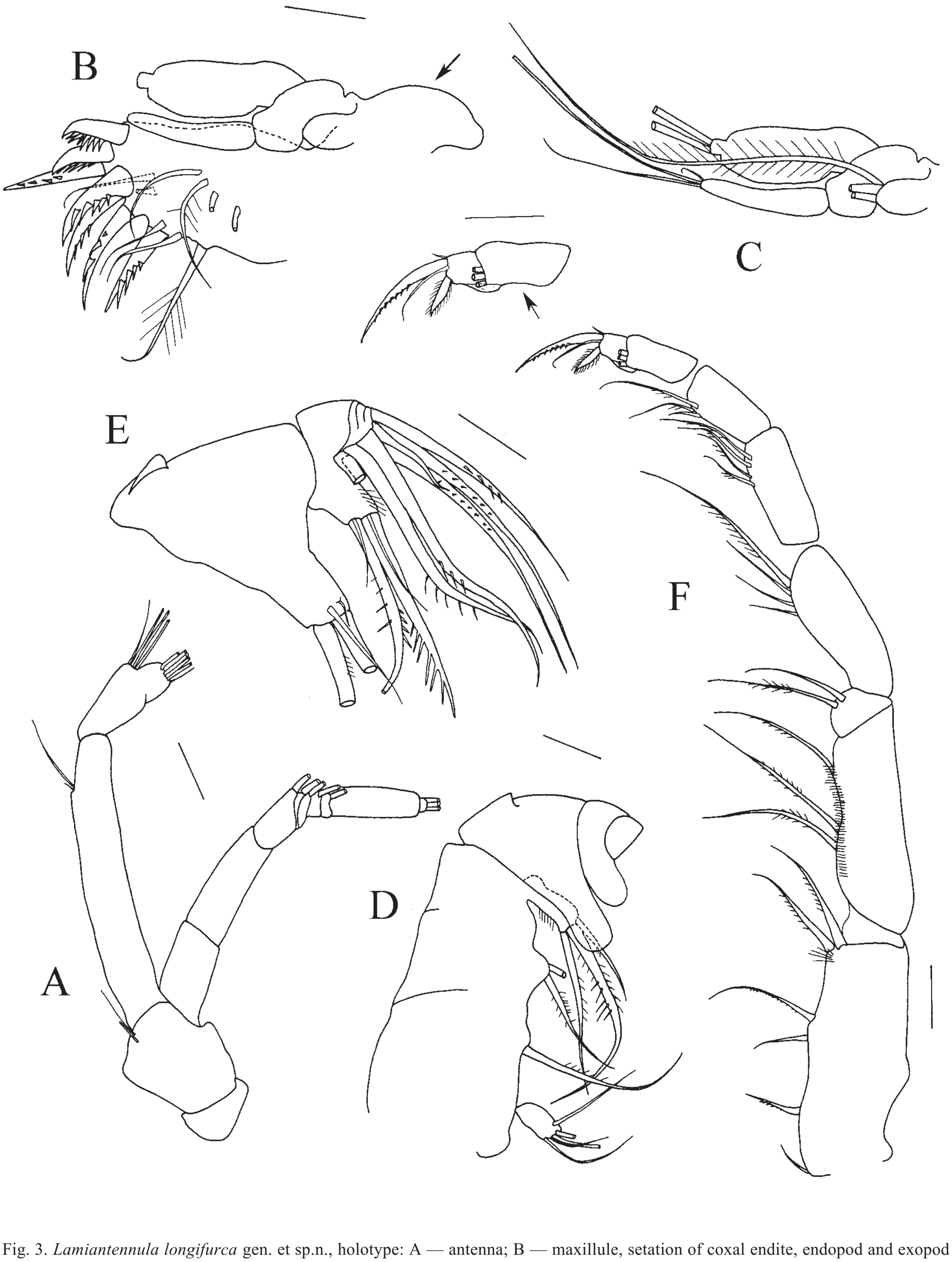


Fig. 3. *Lamiantennula longifurca* gen. et sp.n., holotype: A — antenna; B — maxillule, setation of coxal endite, endopod and exopod omitted (arrow indicates epipodite); C — maxillule, coxal endite, endopod and exopod; D — maxilla, armature of basis and endopod omitted; E — maxilla, basis and terminal part of limb with endite and endopod; F — maxilliped, inner lamella of endopodal segments 5 and 6 stippled. Scale bars 0.1 mm.

Fig. 3. *Lamiantennula longifurca* gen. et sp.n., голотип: A — антенна; B — максиллула, не изображено вооружение коксального эндита, эндоподита и экзоподита (стрелка указывает на эпиподит); C — максиллула, коксальный эндит, эндоподит и экзоподит; D — максилла, не изображено вооружение базиса и эндоподита; E — максилла, базис и терминальная часть конечности с эндитом и эндоподит; F — максиллипеда, внутренняя пластинка сегментов эндоподита 5 и 6 выделена точками. Масштаб 0,1 мм.

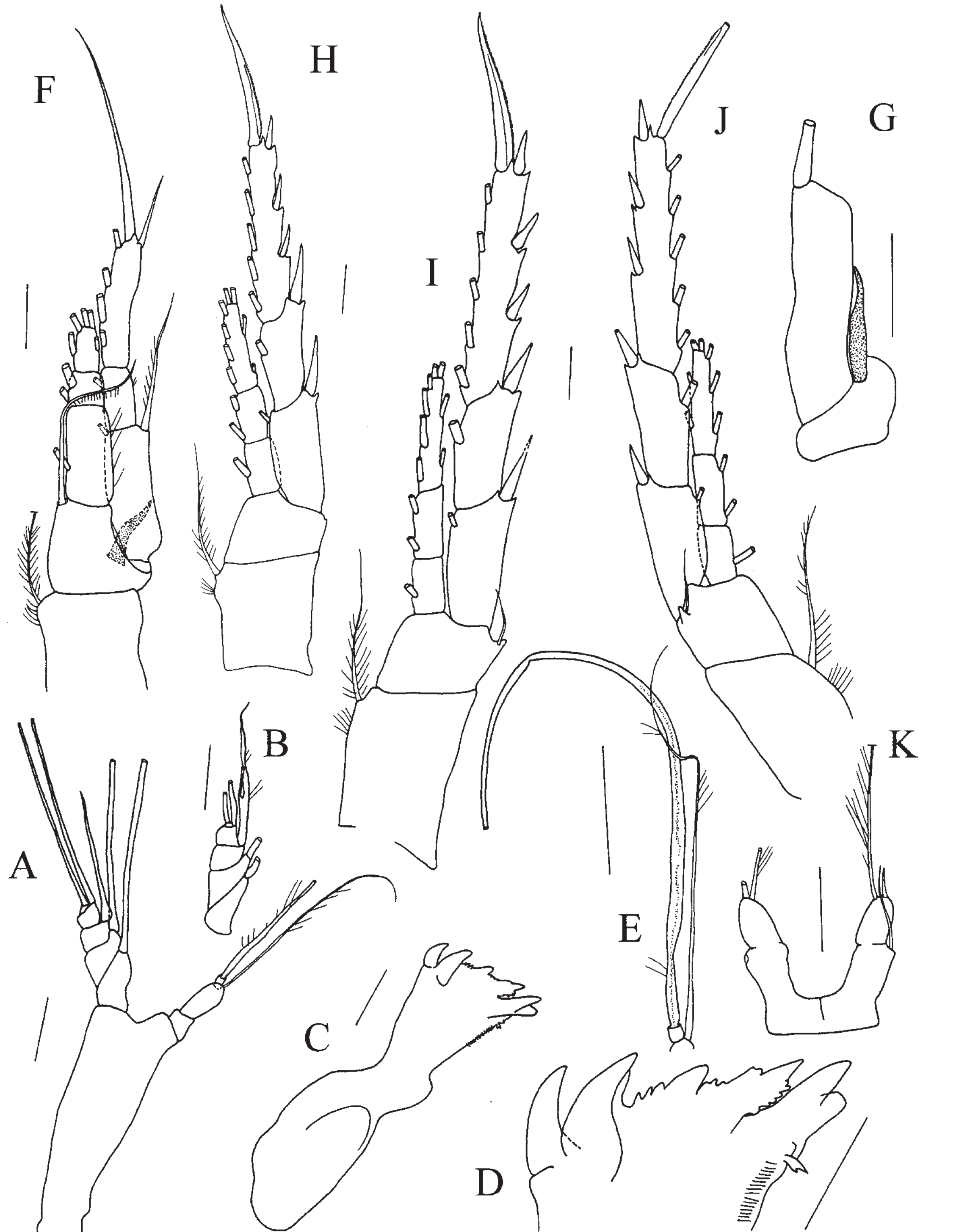


Fig. 4. *Lamiantennula longifurca* gen. et sp.n., holotype: A — right mandible, palp; B — left mandible, exopod; C — left mandible, gnathobase; D — left mandible, teeth of cutting edge; E — left mandible, terminal setae of endopod segment 2; F — Leg 1, anterior view; G — Leg 1 basis with poorly sclerotized posterior spine and exopod segment 1, lateral view; H — Leg 2, posterior view; I — Leg 3, posterior view; J— Leg 4, posterior; K — Leg 5. Scale bars 0.1 mm.

Fig. 4. *Lamiantennula longifurca* gen. et sp.n., голотип: A — правая мандибула, щупик; B — левая мандибула, экзоподит; C — левая мандибула, гнатобаза; D — левая мандибула, зубцы жевательного края; E — левая мандибла, терминальные щетинки сегмента 2 эндоподита; F — первая пара плавательных ног, передняя поверхность; G — первая пара плавательных ног, базис со слабо хитинизированным шипом на задней поверхности и сегмент экзоподита 1, вид сбоку; H — вторая пара плавательных ног, задняя поверхность; I — третья пара плавательных ног, задняя поверхность; J — четвертая пара плавательных ног, задняя поверхность; K — пятая пара плавательных ног. Масштаб 0,1 мм.

observed), 4 large terminal setae and 1 small dorsal seta (Fig. 1E–F, I).

Antennules broken on both sides; left with 17 free segments retained (Fig. 1A, 2A–B), armature as follows: I–III–[2s + 1ae, 2s, 2s + 1ae], IV–2s, V–2s + 1ae, VI–2s , VII–2s + 1ae, VIII–2s, IX–2s + 1ae, X–2s, XI–1s + 1ae, XII–1s+ ?, XIII–2s + 1ae, XIV–2s + 1ae, XV–2s + 1ae, XVI–2s + 1ae, XVII–1s + 1ae, XVIII–2s + 1ae, XIX–1s + 1? Right antennule: only lamelliform complex (segments I–III) and following segment retained. Lamelliform complex of ancestral segments I-III expanded anteriorly and dorso-ventrally compressed.

Antenna (Fig. 3A), coxa without seta; basis with 2 unequal setae; exopod 9-segmented as long as endopod, with 0, 0, 1, 1, 1, 1, 1, 0 and 3 setae; endopod segment 1 with 2 subdistal setae, segment 2 with 4 + 6 setae.

Mandible (Fig. 4A–E), gnathobase with 6 large teeth plus small subdistal dorsolateral tooth; basis elongate without setae, exopod 5-segmented with 1, 1, 1, 1 and 1 setae, seta of segment 3 short with bulbous base, bifurcate on left limb (Fig. 4B); endopod segment 1 small and without setae; segment 2 with 2 setae, one comparatively thick, poorly sclerotized with collar around its base.

Maxillule (Fig. 3B–C), praecoxal arthrite larger than rest of appendage, with a total of 16 elements: 3 slender setae plus 7 robust spinulose spines, 4 posterior and 2 anterior setae; coxal endite with 3 setae; proximal basal and distal basal endites reduced, unarmed; endopod long with 3 distal setae; exopod with 2 distal setae; coxal epipodite without setae.

Maxilla (Fig. 3D–E), proximal praecoxal endite with 5 setae; distal praecoxal endite with 1 seta; proximal coxal endite with 2 setae; distal coxal endite with 3 setae; basis with angular outer crest; proximal basal endite with 4 setae (1 very small); terminal part of maxilla (endopod?) proximally with 4 setal elements on first large endite (2 thick and spinulose spines, 2 thin short setae) and distally with 6 long and 1 short strong, spinulose setae.

Maxilliped (Fig. 3F), praecoxal proximal and middle endites with 1 seta each, distal endite with 2 setae; coxal endite with 2 setae; basis with 3 medial setae; endopod 6-segmented with 2, 4, 4, 3, 3 and 4 setae; segment 5 distally and segment 6 with inner lamella (stippled in Fig. 3F); segment 6 with 4 unequal distal setae: 1 spinulose, the longest and strongest, 1 short seta spinulose on both sides, 1 short outer and 1 long slender seta.

Legs 1–4 with 3-segmented endo- and exopods.

Leg 1 (Fig. 4F–G), coxa with medial seta, basis with distomedial seta strongly curved and with poorly sclerotized spine on posterior face; endopod segment 1 with 1 medial seta; segment 2 with 2 medial setae, segment 3 with 2 medial, 2 terminal and 1 lateral setae; exopod segment 1 largest with 1 medial seta and 1 long lateral spine; segment 2 with 1 medial seta without lateral spine; segment 3 with 4 medial setae, 1 terminal and 1 lateral spine.

Leg 2 (Fig. 4H), coxa with medial seta, basis without seta; endopod segment 1 with 1 medial seta, segment 2 with 2 medial setae, segment 3 with 4 medial, 2 terminal and 2 lateral setae; exopod segment 1 with 1 medial seta and 1 lateral spine; segment 2 with 1 medial seta and 1 lateral spine; segment 3 with 5 medial setae, 1 terminal and 3 lateral spines.

Leg 3 (Fig. 4I), coxa with medial seta, basis with lateral seta; endopod segment 1 with 1 medial seta; segment 2 with 2 medial setae; segment 3 with 4 medial, 2 terminal and 2 lateral setae; exopod segment 1 with 1 medial seta and 1 lateral spine; segment 2 with 1 medial seta and 1 lateral spine; segment 3 with 5 medial setae, 1 terminal and 3 lateral spines.

Leg 4 (Fig. 4J) similar to leg 3, but endopod segment 3 with 3 medial setae.

Leg 5 (Fig. 4K) symmetrical, uniramous; coxa and basis fused, with 1 distolateral seta; 1-segmented exopod incompletely separate from basis, with 2 terminal setae (1 long, 1 short and spine-like).

ETYMOLOGY. The species name “*longifurca*” refers to the exceptionally long caudal rami.

Lamiantennula sp.

Copepodite IV, female. Total length 2.15 mm. General habitus as in adult female of *L. longifurca*. Urosome of 3 somites; caudal rami slightly asymmetrical, with setal armament as in type species. Antennule 24-segmented, exceeding body by 3 distal segments. Antennulary lamelliform complex of proximal segments I–III as in type species; but setation is 2s + 1s + 1s + 1ae.

Antenna as in *L. longifurca*.

Mandible as in *L. longifurca*, except for seta of endopod segment 2 without collar around its base and seta of exopod segment 3 without bulbous base.

Maxillule as in *L. longifurca*, except for praecoxal arthrite with 6 robust spinulose spines.

Maxilla as in *L. longifurca* except for 1 spine on endite of terminal part of the limb is distinctly shorter.

Maxilliped syncoxa as in *L. longifurca*. Basis with 3 setae and 2 setae of first endopodal segment incorporated to basis. Endopod of 4 free segments with 2, 2, 1 and 4 setae; terminal segments without lamella.

Legs 1 to 4, coxa and basis as in *L. longifurca,* but endo- and exopods 2-segmented.

P5 as in *L. longifurca*, except for suture line of exopod subdivision better developed and right exopod segment with 2 small terminal spines and 1 long seta.

Discussion

The new genus is readily distinguished among arietelloideans by the proximal segments of antennule being fused as a large lamelliform complex; further, the mandibular endopod segment 2 has 2 setae, the exopod bears 5 setae, and the basis of maxilla has a marked outer crest.

Lamiantennula longifurca shares unusually long caudal rami with the monotypical arietelloidean family Lucicutiidae Sars, 1902. It differs, however, in main diagnostic characters typical of *Lucicutia* Giesbrecht, 1898: basis of leg 1 lacking tubular process itemized in the diagnosis of *Lucicutia* by Hulsemann [1966: 703] and, correspondingly, has no large pore with inner seta originating on the outer, posterior wall of pore as described by Markhaseva & Ferrari (2005: 1094); the seta in the new genus originates distomedially directly from the basis. *Lamiantennula* is also distinguished from *Lucicutia* in shape and setation of oral parts and a short uniramous leg 5. The new genus appears related to a group of three arietelloidean families [Soh, 1998: 208, 227], viz. Hyperbionychidae, Nullosetigeridae Soh, Ohtsuka, Imabayashi & Suh, 1999 and Arietellidae Sars, 1902 with which it shares: i) the reduced number of setae on the antenna endopod segment 2; ii) complete loss of setae on the basis of mandibular palp; iii)

reduced setation on mandibular endopod segment 2; iv) the reduced number of setae on the exopod of maxillule.

With families Hyperbionychidae and Nullosetigeridae the new genus shares an enlarged praecoxal arthrite of maxillule, with the latter family it also shares the loss of setae on the epipodite of maxillule.

The new genus shares the following apomorphies with the genus *Hyperbyonix* Ohtsuka, Roe, Boxshall, 1993 of the family Hyperbionychidae: i) reduction of setal armament on mandibular endopod segment 1; ii) presence of 2 setae on maxillulary exopod; iii) reduction of the distal basal endite of maxillule; iv) distal praecoxal endite of maxilla bearing 1 seta; v) leg 1 exopod segment 2 without 1 lateral spine. The new genus also shares with *Hyperbyonix* the shape of the posterior margin of labrum that is produced on both sides, asymmetry of the genital double-somite and the presence of a lateral seta on the basis of leg 3 and 4.

Lamiantennula longifurca is distinguished from *Hyperbyonix* in: i) symmetrical, very long caudal rami (asymmetrical, short rami, right ramus longer than left, in *Hyperbyonix*); ii) the number of teeth on mandibular gnathobase (7 vs. 2 teeth in *Hyperbyonix*); iii) armament of maxillular praecoxal arthrite (16 setal elements vs. 13), endopod (3 vs. 5), and epipodite lacking seta (2 setae in *Hyperbyonix*); iv) maxilla endopod with 7 setae (6 in *Hyperbyonix*);

v) armature of maxilliped syncoxa as 1, 1, 2, 2 (0, 1, 1, 2 in *Hyperbyonix*); vi) maxilliped endopod segment 1 separate from basis (incompletely separate in *Hyperbyonix*); vii) leg 1 exopod segment 3 with 1 lateral spine (2 spines in *Hyperbyonix*); viii) leg 5 incompletely 2-segmented with 2 setae on exopod (3-segmented with 5 setal elements on exopod in *Hyperbyonix*).

However, despite these significant differences between *Hyperbyonix* and *Lamiantennula*, until the male will be described the new genus is preliminarily placed in the family Hyperbionychidae as the probable most related arietelloidean family.

ACKNOWLEDGEMENTS. The authors thank Profs Angelika Brandt and Pedro Martinez Arbizu for providing the unsorted copepod fraction of ANDEEP II and DIVA I expeditions, which yielded the specimens analysed in this paper. Research of E.L. Markhaseva at Deutsches Zentrum fuer Marine Biodiversitaetsforschung (DZMB-Senckenberg, Biozentrum Grindel & Zoologisches Museum Hamburg (Zoological Museum Hamburg)) was funded by CeDAMar (Census of the Diversity of Abyssal Marine Life) and Deutsche Forschungsgemeinschaft (DFG) (GZ 436RUS17/129/05). This is ANDEEP publication 57.

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